

Section 1.4: Converting between Binary, Octal, and Hexadecimal

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10:40 AM

Octal, and Hexadecimal

converting between binary and octal:

octal	binary
0_8	$0_2 = 000_2$
1_8	$1_2 = 001_2$
2_8	$10_2 = 010_2$
3_8	$11_2 = 011_2$
4_8	100_2
5_8	101_2
6_8	110_2
7_8	111_2

$$\begin{aligned} 6_8 &= 110_2 \\ 3_8 &= 011_2 \\ 4_8 &= 100_2 \end{aligned}$$

$$\text{so } 634_8 = 110 \ 011 \ 100_2$$

nifty, no?

example: convert the following octal numbers into binary:

$$\text{a) } 15_8 = 001 \ 101 = 1101_2$$

$$\text{b) } 703_8 = 111 \ 000 \ 011 = 111000011_2$$

or $1 \ 1100 \ 0011_2$ (spacing)

binary \rightarrow octal works in the way you'd expect:

group the digits into sets of three, starting from the right-hand side

$$10101110_2 \rightarrow \text{octal}$$

$$\begin{array}{ccc} 10 & 101 & 110 \\ \hline 2 & 5 & 6 \end{array}$$

$$\text{so } 10101110_2 = 256_8$$

examples:

$$\begin{array}{l} \text{a) } 101_2 = 5_8 \\ \text{b) } 1011_2 = 13_8 \\ \text{c) } 1111001101110_2 = 17156_8 \end{array}$$

octal	binary
0 ₈	000 ₂
1 ₈	001 ₂
2 ₈	010 ₂
3 ₈	011 ₂
4 ₈	100 ₂
5 ₈	101 ₂
6 ₈	110 ₂
7 ₈	111 ₂

hexadecimal works the same way, except that you use groups of 4:

hexadecimal	binary
0 ₁₆	0000 ₂
1	0001

hexadecimal	binary
8 ₁₆	1000 ₂
9	1001

0_{16}	0000_2	8_{16}	1000_2
1_{16}	0001_2	9_{16}	1001_2
2_{16}	0010_2	A_{16}	1010_2
3_{16}	0011_2	B_{16}	1011_2
4_{16}	0100_2	C_{16}	1100_2
5_{16}	0101_2	D_{16}	1101_2
6_{16}	0110_2	E_{16}	1110_2
7_{16}	0111_2	F_{16}	1111_2

so $E8_{16} = 1110\ 1000_2$

examples: convert to binary:

① $94_{16} = 1001\ 0100_2$

② $FAB_{16} = 1111\ 1010\ 1011_2$

converting between octal and hexadecimal:

best way? convert to binary first, then we regroup the digits

example: convert 705_8 to hexadecimal

$$705_8 = 111\ 000\ 101_2$$

$$= 1\ 1100\ 0101_2$$

$$= 1C5_{16}$$

regroup into fours, starting from right

examples: perform the following conversions

a) $5670_8 \rightarrow$ hexadecimal

b) $30D1_{16} \rightarrow$ octal

$$\begin{aligned} \text{a) } 5670_8 &= 101\ 110\ 111\ 000 \\ &= 1011\ 1011\ 1000 \\ &= B\ B\ 8_{16} \end{aligned}$$

$$\begin{aligned} \text{b) } 30D1_{16} &= 0011\ 0000\ 1101\ 0001 \\ &= 11\ 000\ 011\ 010\ 001 \\ &= 3\ 0\ 3\ 2\ 1_8 \end{aligned}$$